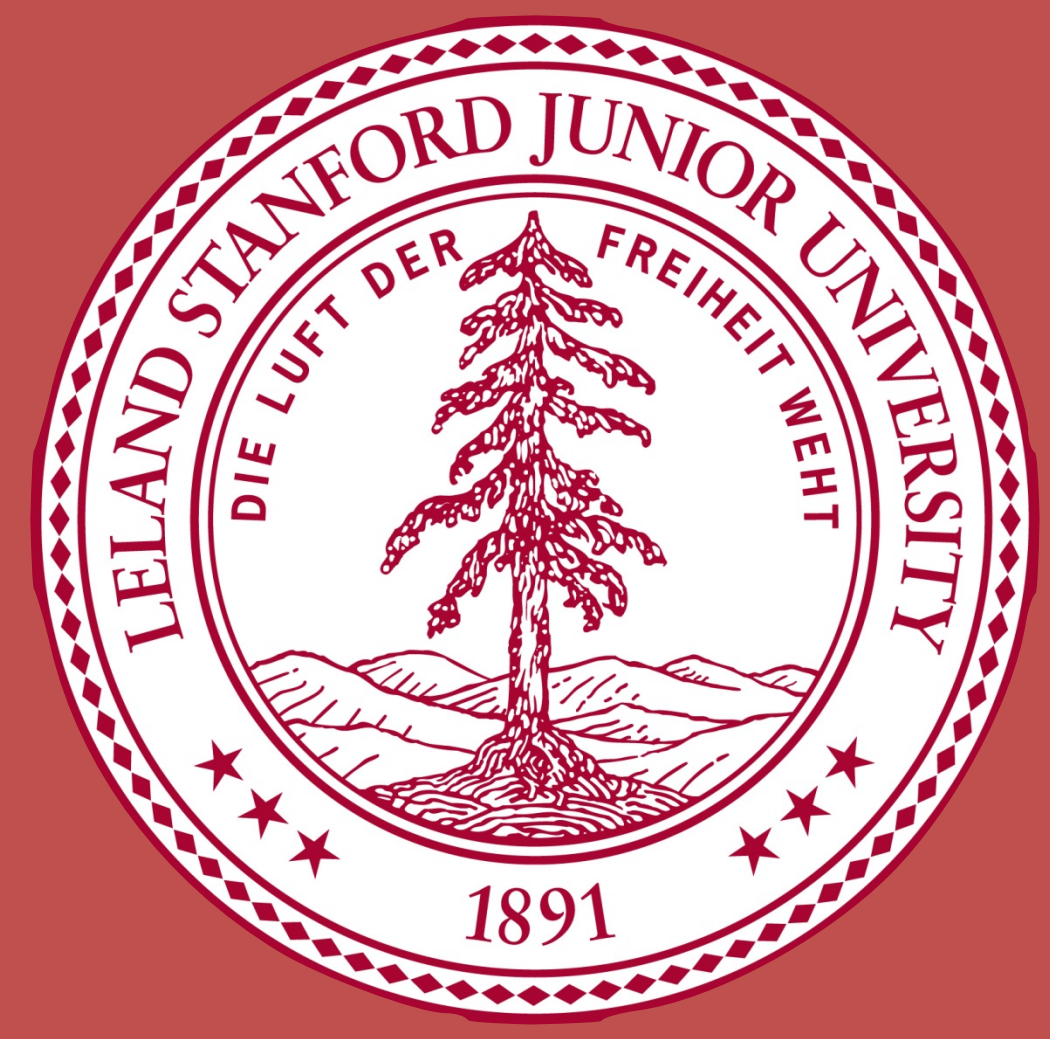


CT-based Patient Triage of COVID-19: Radiomics Prediction of ICU Admission, Mechanical Ventilation, and Death of Patients



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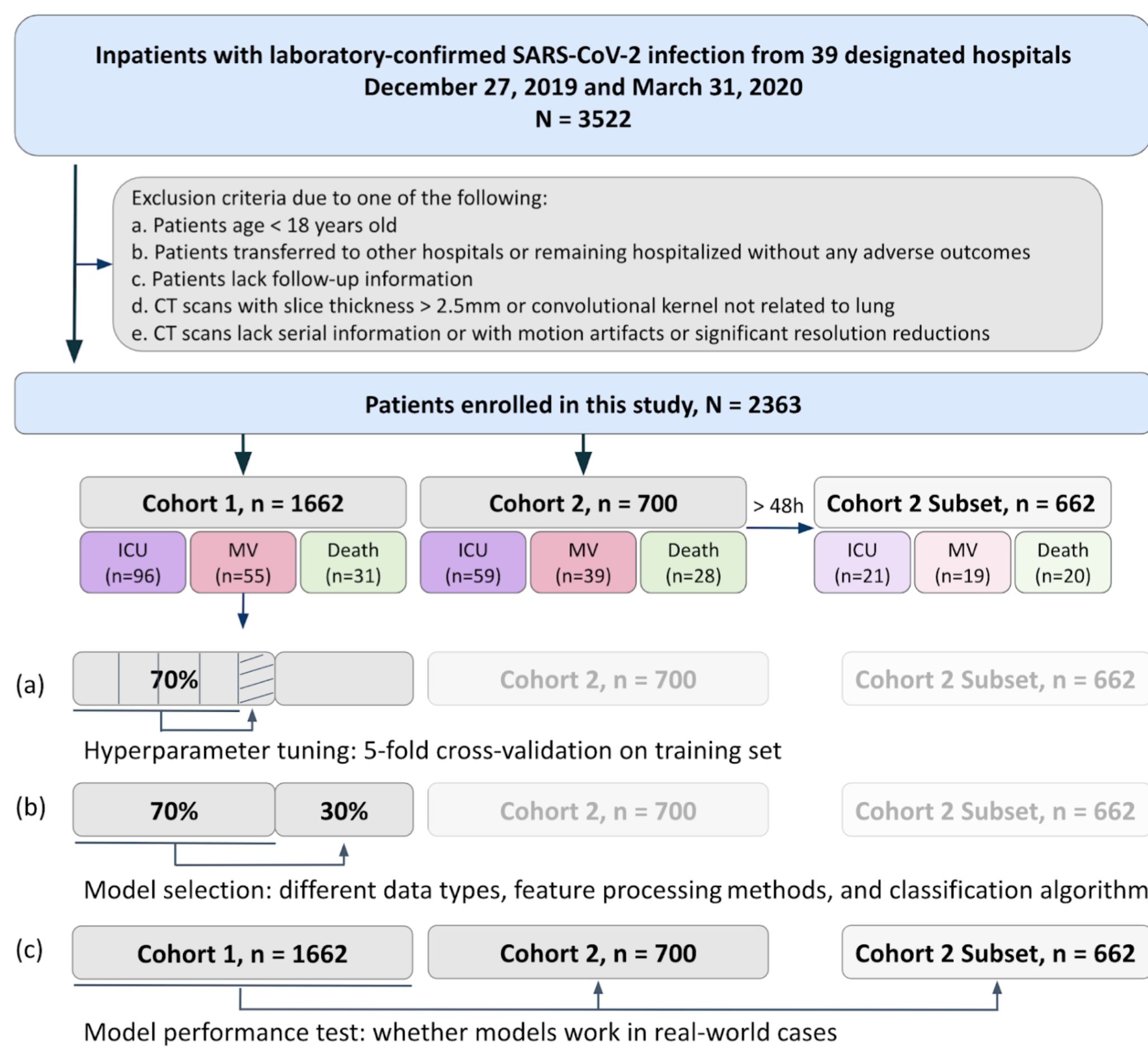
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Introduction

In order to achieve rapid stratification and timely intensive care of COVID-19 patients, as well as the optimization of medical resource allocation under this unprecedented public health emergency, in this study, prediction models, which take radiomics based features, are built to predict high-risk inpatients at the time of admissions.

Data and Study Design

1. Flowchart of the study



2. Data Types and Feature Engineering

- Data Types
 - (i) Radiomics features (Radiom)
 - (ii) Laboratory results (Lab)
 - (iii) Clinical features (Clin)
 - (iv) Radiologist findings.

- Feature Engineering Methods
 - 1) SMOTEENN ^[1]
 - 2) PCA [2-4]
 - 3) LASSO feature selection ^[5]
 - 4) GUS (generic univariate selection)
 - 5) FPR (false positive rate test).

Prediction Models

- Logistic Regression (LR)
- Random Forest (RF)
- Support Vector Machine(SVM)
- Multilayer Perceptron(MLP)
- LightGBM

Results

- We first tested the models on Cohort 1

	ICU			MV			Death		
Data	AUROC	ACC	AUPRC	AUROC	ACC	AUPRC	AUROC	ACC	AUPRC
Radiom	0.732	0.780	0.261	0.823	0.954	0.307	0.881	0.970	0.300
RadioClin	0.836	0.826	0.383	0.836	0.826	0.383	0.948	0.960	0.395
RadioClinLab	0.837	0.824	0.307	0.850	0.970	0.420	0.826	0.984	0.417
ClinLab	0.876	0.784	0.335	0.876	0.784	0.335	0.838	0.968	0.121
R Score	0.600	0.939	0.096	0.607	0.967	0.065	0.704	0.979	0.056

Table 1. The performances of optimal models on the test set of Cohort 1.

- Then optimal models are chosen and tested on Cohort 2

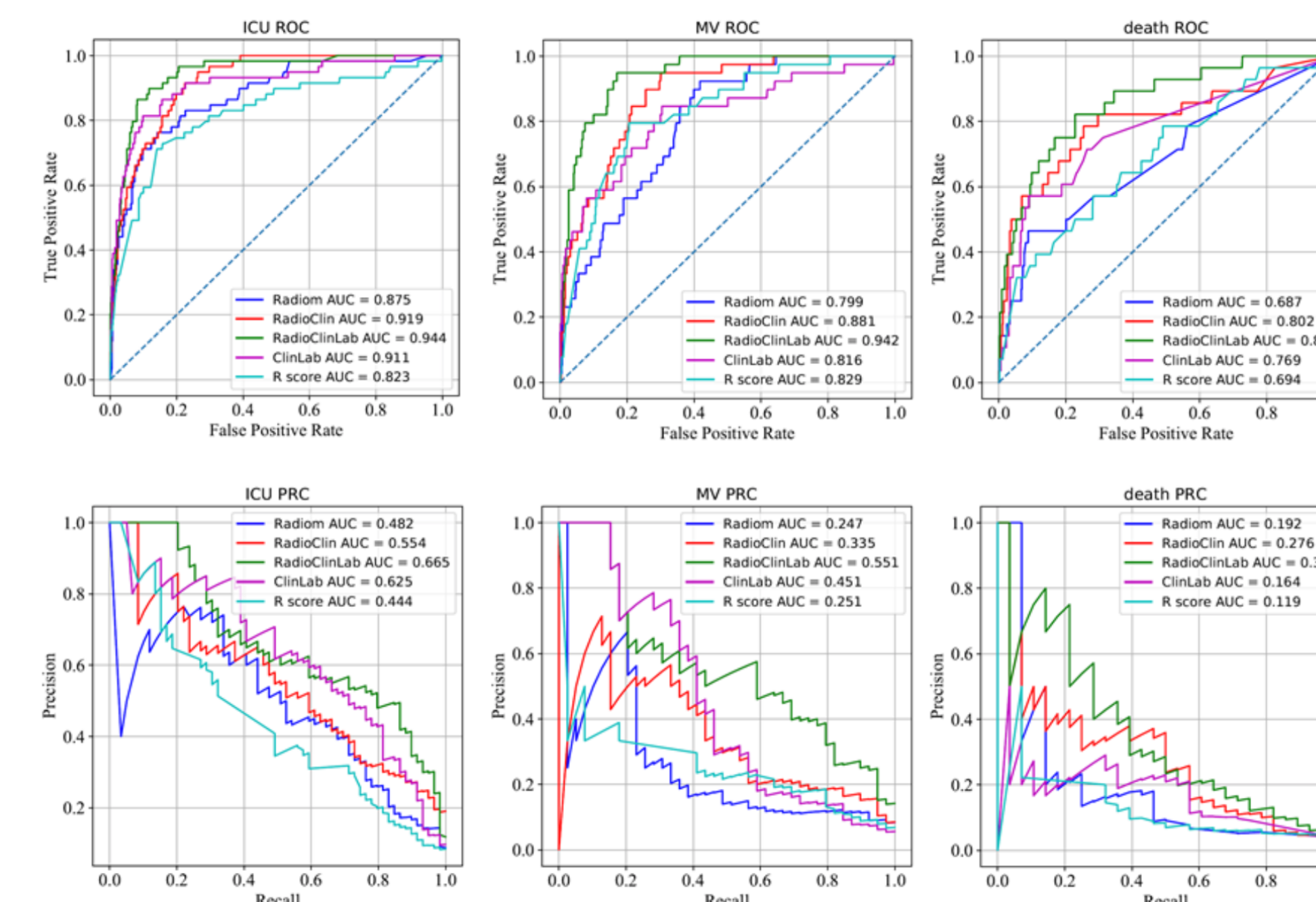


Fig. 2 The receiver operating characteristic curves and the precision recall curves of the optimal models on predicting samples in Cohort 2.

- Bootstrapping results in Cohort 2 shows RadioClin models outperformed Radiom models; RadioClinLab models outperformed ClinLab models in MV and death

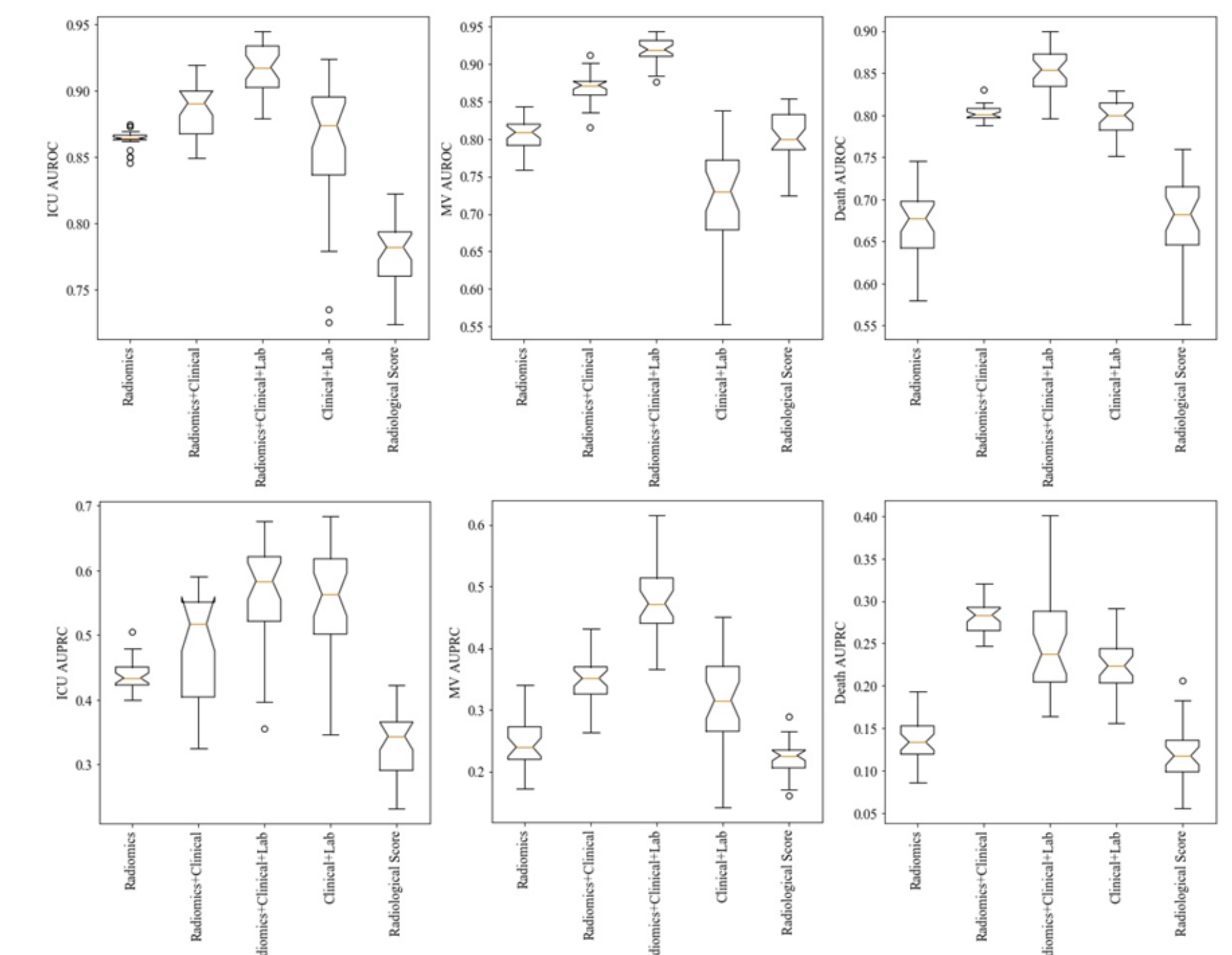


Fig. 3 Box plots of the AUROC and AUPRC in thirty bootstrapping experiments on Cohort 2.

Conclusion

- The models were trained on a cohort of 1662 COVID-19 patients and the performances were validated on an unseen cohort of 700 COVID-19 patients with high AUROC and AUPRC.
- The model with radiomics, demographics, clinical symptoms, comorbidity and lab tests showed the best performances on three prediction tasks while various models based on different types of data could also enable the users to flexibly choose based on the data available.
- This work enables the risk evaluation of COVID-19 patients and facilitates the resource allocation to those with high risks.